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# **PROPULSION DIRECTORATE**

## **Monthly Accomplishment Report March 2005**

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#### NEW PATENT BENEFITS VARIOUS TECHNICAL DISCIPLINES:

On 15 March 2005, AFRL researchers were issued [U.S. Patent No. 6,867,854](#), titled "Liquid to Solid Angle of Contact Measurement." The inventors of this patent are Drs. Phil Wapner and Wes Hoffman of the Propulsion Directorate's High Temperature Components Group. This patent demonstrates an entirely new technique for measuring liquid contact angles on surfaces that is very simple and does not require a microscope and image analysis software. The technique utilizes the fact that non-planar surfaces may or may not be fully contacted by partially-wetting liquids depending on the shape of variations on the solid surface. A simple algorithm relates the geometry of these variations to the planar contact angle. The wetting behavior of a liquid on a solid surface is a phenomenon of significant practical importance. The angle of liquid-to-solid contact is important in such diverse areas as adhesion, adsorption, lubrication, catalysis, solid-liquid reaction kinetics, heat transfer, electrical conduction, and micro-fluidic devices. With the expanded need in the scientific and technical community to measure the contact angle of liquids on various surfaces, there is a commensurate need for a rapid and inexpensive means to accurately measure both the static and dynamic contact angles of liquids on solid surfaces. (Dr. W. Hoffman, AFRL/PRSM, (661) 275-5768)



Dr. Wesley Hoffman



Dr. Phil Wapner

#### SUPERCONDUCTIVITY GROUP DEMONSTRATES THAT LESS CAN BE MORE:

AFRL's Superconductivity Group recently demonstrated for the first time that minute additions (<1%) of certain divalent rare earth elements can improve the properties of YBCO (yttrium barium copper oxide) superconducting films. Previously, larger percentage additions (e.g., 10%, 20%, etc.) had been used by the superconductor community for altering the superconducting properties of rare earth barium cuprate superconductors, as small percentage additions were considered to have little effect. The divalent elements terbium (Tb), cerium (Ce), and praseodymium (Pr) have shown to be detrimental when added in these larger quantities and were consequently ignored. However, the Propulsion Directorate's Dr. Paul Barnes recognized the potential use of the detrimental nature of these elements. He determined that if used in small

quantities well dispersed throughout the YBCO superconductor, they can act as nanopinning centers and improve the critical current. Mr. Joseph Kell, an AFRL/PR co-op student working on his Master's thesis, recently demonstrated that this hypothesis is indeed true (with Ce and Tb), as higher in-field critical currents were realized. The Superconductivity Group is currently optimizing the result to determine the maximum improvement possible via this method, and testing will soon begin on Pr doped samples. This research supports the development of high temperature superconducting (HTS) technology, which is an essential element needed for the design and development of future advanced, compact, high-power generator coils for aerospace applications, such as directed energy weapons. (Dr. P. Barnes, AFRL/PRPG, (937) 255-4410)



Dr. Paul Barnes (L) and Mr. Joseph Kell (R)

**DR. REITZ WINS PRESTIGIOUS AFMC ENGINEERING AWARD:** The winners of the 2004 AFMC Engineering and Technical Management (E&TM) Awards were recently announced, and the Propulsion Directorate's Dr. Thom Reitz was among the honorees. Dr. Reitz was selected as the winner of the General James Ferguson Engineering Award. He was recognized for leading fuel cell research to provide quiet, clean, efficient and reliable solutions for aircraft auxiliary power units, unmanned aerial vehicle prime power, and portable power for deployed Airmen, using battlefield-available fuels. Dr. Reitz's work is expanding the fundamental knowledge of fuel cell chemistry and is driving significant improvements to the efficiency and longevity of fuel cell technology. Propulsion Directorate personnel were candidates for three additional AFMC E&TM Awards. Mr. Brett Jordan, Capt William Notbohm, and PR's Battlefield Renewable Integrated Tactical Energy System Team were nominated for the Junior Civilian Engineering Award, the Capt Roland R. Obenland Memorial Award, and the General Bernard P.



Mr. Thomas Reitz



Mr. Parker Buckley

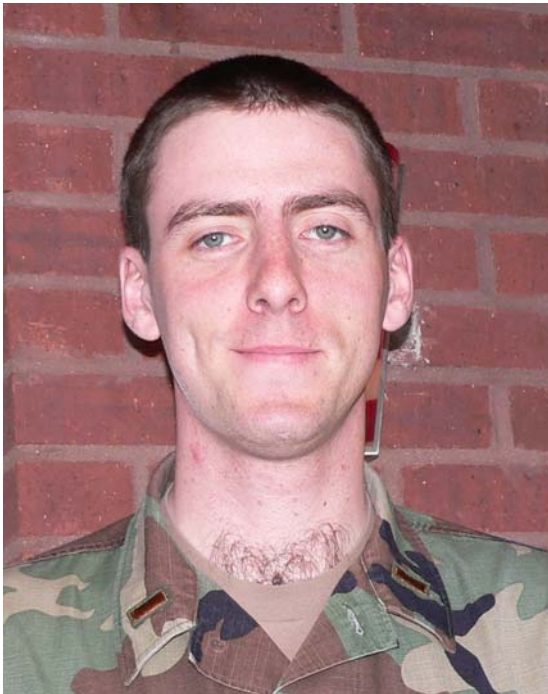
Randolph Engineering Team Award, respectively. The AFMC E&TM Awards will be presented at a banquet in Dayton, Ohio, on 11 May 2005. (Mr. J. Nairus, AFRL/PRPS, (937) 255-5948)

MR. BUCKLEY RECOGNIZED FOR LEADERSHIP OF HYPERSONIC RESEARCH:

AFRL's Mr. Parker L. Buckley was recently selected to receive the prestigious Meritorious Civilian Service Award. Mr. Buckley was recognized for his distinguished performance as Chief of the Propulsion Directorate's Aerospace Propulsion Division (AFRL/PRA) from October 2000 to January 2005. With the inception of the Aerospace Propulsion Division in October 2000, Mr. Buckley accepted the challenge of furthering the science of hypersonic propulsion for application to Air Force weapons and space access platforms. During this period, AFRL/PRA earned a position of international prominence in hypersonic propulsion through a multifaceted approach consisting of a world-class in-house research program combined with exceptional management of extramural programs with their industry partners. Mr. Buckley's leadership during this time was instrumental in his group achieving the first-ever freejet demonstration of a hydrocarbon-fueled scramjet engine operating on conventional jet fuel. This earned members of his team the coveted *Aviation Week and Space Technology* Laurel Award as 2003's top achievement in aviation. This success was followed a year later by the first-ever freejet demonstration of the scramjet in a *fuel-cooled* configuration; thus establishing the viability of this engine concept for application to future weapon systems and space access vehicles. These milestones constitute some of the most important achievements in hypersonic propulsion in many years. (Col M. Heil, AFRL/PR, (937) 255-2520)



AFRL PARTICIPATION VITAL TO SUCCESSFUL AIAA SYMPOSIUM: The 30<sup>th</sup> American Institute of Aeronautics and Astronautics (AIAA) [Dayton-Cincinnati Aerospace Sciences Meeting](#) (DCASS) was held in Dayton, Ohio, on 8 March 2005. Wide-ranging participation from AFRL's Propulsion Directorate helped ensure another successful symposium. AFRL/PR personnel served in leadership roles for the meeting with seven AFRL/PR government and on-site contractor personnel serving as committee chairpersons in a variety of areas. Furthermore, 13 of the 44 technical sessions held at the symposium were chaired by AFRL/PR personnel. AFRL/PR personnel were also active participants in the meeting, contributing more than 30 of the roughly 200 papers presented. Three of the presentations made by AFRL/PR personnel were honored with DCASS Best Presentation Awards in their respective technical areas. These Best Presentation Awards went to 2Lt Jack Barnett in the category of Combustion,<sup>\*</sup> Dr. James R. Gord in the category of Imaging & Diagnostics,<sup>†</sup> and Ms. Rajee Assudani<sup>‡</sup> in the category of Fuels & Acoustics.<sup>§</sup> The award winners will be formally honored at the AIAA Dayton-Cincinnati Section Annual Awards on 16 May 2005. (Col M. Heil, AFRL/PR, (937) 255-2520)



2Lt Jack Barnett



Dr. James Gord

MS. SARGENT HONORED FOR WORK ON ADVANCED ROTOR: AFRL's Ms. Kathleen Sargent was recently selected to receive the Exemplary Civilian Service Award. Ms. Sargent, an

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<sup>\*</sup> **Jack P. Barnett**, Skip Williams, Lance Jacobsen, and Cam Carter, "Operational Characteristics, Metrics, and Ignition Results of Plasma Torch Modules as Igniters for Scramjet Engines."

<sup>†</sup> **James R. Gord**, Barry Kiel, Terrence R. Meyer, Megan Paciaroni, and Mark A. Linne, "Ballistic Imaging of Liquid Column Break-Up in Dense Sprays Using Femtosecond Lasers."

<sup>‡</sup> Ms. Assudani is a University of Dayton graduate student supported by AFRL/PR whose advisors (and co-authors) are AFRL/PR on-site contractors.

<sup>§</sup> **Rajee Assudani**, Jamie S. Ervin, and Steven Zabarnick, "Numerical and Experimental Studies of Jet Fuel Near the Freeze Point Temperature."

aerospace engineer in the Propulsion Directorate's Structures and Controls Branch (AFRL/PRTS), was recognized for her distinguished service from October 2000 to January 2005. During this time, Ms. Sargent made outstanding contributions to the Air Force through her initiative, technical expertise, and strong leadership. She applied these qualities to the planning, execution, and follow-up phases of the development and demonstration of a new design concept -- the Metal Matrix Composite (MMC) Remote Ring Compressor Rotor. She led a joint government and industry team in overcoming serious fabrication and manufacturing shortcomings in this technology area to bring the remote ring rotor to fruition. As a result of her efforts, a new method of fabricating MMC rotors has been developed and validated, and is currently being incorporated into advanced turbine engines. During this period, Ms. Sargent also chaired the 2002 Turbine Engine Technology Symposium (TETS). The TETS is the only forum where the US turbine engine community gathers to review and discuss the latest technology advances achieved through the Integrated High Performance Turbine Engine Technology (IHPTET) and Versatile Affordable Advanced Turbine Engines (VAATE) Programs. As symposium chairman, she directed every aspect of this highly successful symposium. (Ms. L. Fry, AFRL/PRTS, (937) 255-7231)



Ms. Kathleen Sargent

PR TAKES LEADERSHIP ROLE IN HIGH CYCLE FATIGUE CONFERENCE: The [10<sup>th</sup> National Turbine Engine High Cycle Fatigue \(HCF\) Conference](#) was held from 8-11 March 2005 in New Orleans, Louisiana. Once again, Propulsion Directorate personnel contributed to the success of the conference by filling a number of key roles in the organization and execution of the conference. PR's Mr. Jeff Brown served as the Deputy Chair for the conference, and PR personnel chaired half of the conference's 14 technical sessions. This conference focused on the critical issue of High



Mr. Jeff Brown

Cycle Fatigue (HCF), which results from vibratory stress cycles induced from various aeromechanical sources. It is a widespread phenomenon in aircraft gas turbine engines that historically has led to the premature failure of major engine components (e.g., fans, compressors, turbines) and in some instances has resulted in loss of the total engine and aircraft. The National HCF Initiative was established in 1994 to address HCF failures prevalent at the time in AF engines. The HCF Program is executed by a cross-directorate team led by the Propulsion Directorate (AFRL/PR) and includes participation by AFOSR and the Materials & Manufacturing Directorate (AFRL/ML), as well as Tri-Service partnerships. Over the last several years, the technologies developed under the High Cycle Fatigue (HCF) Science and Technology (S&T) Program have helped to solve a number of difficult field engine problems and, as a result, the number of major HCF events is falling. (Mr. J. Brown, AFRL/PRTS, (937) 255-7223)